CAB INTERNATIONAL
MYCOLOGICAL INSTITUTE
LIBRARY
- 8 JUN 1992
HUBERT
E.E.
C.1928

Manual of Wood Rots

for

Cruisers and Scalers in the Inland Empire

By ERNEST E. HUBERT

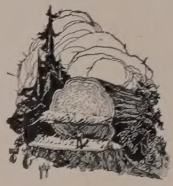
COMPILED AND PRINTED BY
The TIMBERMAN
An International Lumber Journal
GEO. M. CORNWALL, EDITOR
PORTLAND, OREGON, U. S. A.

Manual of Wood Rots

For Cruisers and Scalers in the Inland Empire[1]

By ERNEST E. HUBERT[2]

Professor of Forest Products, School of Forestry,
University of Idaho

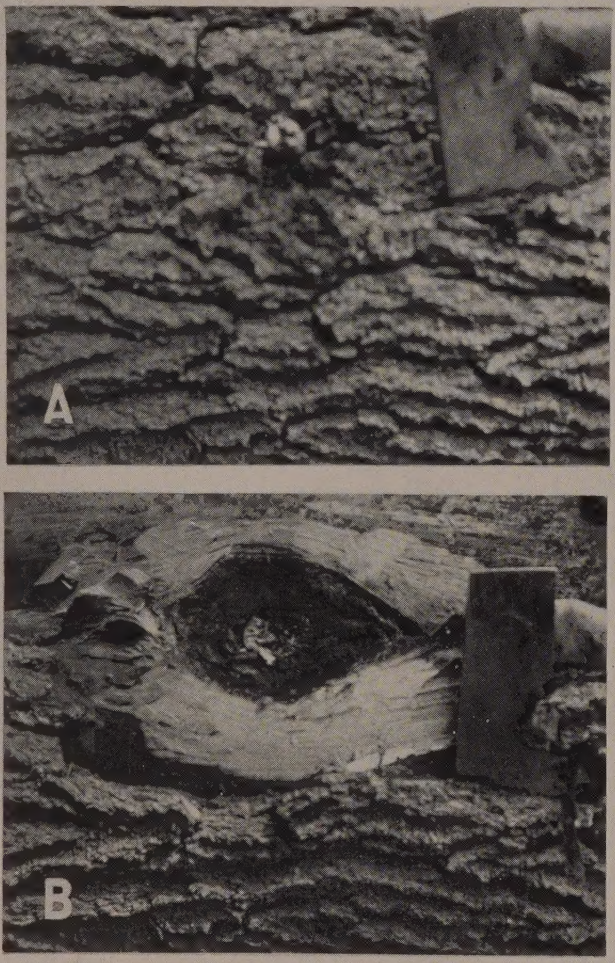


[1] "Inland Empire" is the geographical designation of a section of the northwestern part of the United States and a part of British Columbia, embracing the following states or portions thereof: Western Montana, Idaho, Eastern Washington, Eastern Oregon and Southeastern British Columbia.

[2] Professor of forest products, School of Forestry, University of Idaho, and formerly assistant pathologist, Forest Products Laboratory, Madison, Wis. The photographs showing slash and edge grain views of wood rots were taken at the Forest Products Laboratory, Madison, Wis., and permission to use them is gratefully acknowledged.

FRONTISPIECE

Two views of a punk knot caused by Trametes pini, the ring scale fungus, in a 20-foot western white pine log culled in the woods. Neither end of the log showed decay. The upper view shows a portion of a dead branch issuing from the bark with no outward signs indicating decay. The lower view shows the same punk knot when chopped into, revealing the dark brown punky substance surrounding the decayed knot, which furnishes a reliable clew as to the condition of the log


A
B

LIST OF REFERENCES

(1) Hubert, E. E. "The Diagnosis of Decay in Wood." J. A. R., 29:523-567. Dec., 1924.

(2) Weir, J. R., and Hubert, E. E. "Forest Disease Surveys." U. S. D. A. Bull. No. 658:1-23. June, 1918.

(3) Knouf, C. E., and Weir, J. R. "Trade Course in Log Scaling for Idaho Woods." Idaho Bulletin of Vocational Education 5:1-108. May, 1922.

(4) Meinecke, E. P. "Forest Tree Diseases Common in California and Nevada." U. S. D. A. Manual. Illus. pp. 1-67. 1914.

(5) Weir, J. R., and Hubert, E. E. "A Study of the Rots of Western White Pine." U. S. D. A. Bull. No. 799:1-24. Nov., 1919. "A Study of the Rots of Western Hemlock." U. S. D. A. Bull. No. 722:1-37. Oct., 1918.

(6) Boyce, J. S. "A Study of Douglas Fir in the Pacific Northwest." U. S. D. A. Bull. No. 1163:1-18. July, 1923.

(7) Hubert, E. E. "The Brown Stains of Lumber." The Timberman, 27:44,45,48, 50. May, 1926.

MANUAL OF WOOD ROTS
FOR CRUISERS AND SCALERS IN THE INLAND EMPIRE

By Ernest E. Hubert, University of Idaho

THE cruiser and scaler, more than any other person engaged in the lumber industry with the exception of the lumber grader, needs to know in common terms what is meant by decay in wood, its causes, characteristics, outward signs, effect upon the wood structure and its relative cull-producing properties. He should know the simpler classification of wood rots and should be able to associate the common names of the most important cull-producing rots with the early and late stages of these rots when encountered in the woods. The more information the cruiser possesses relative to the various cull-producing rots common to the trees of his region the more accurate and valuable will be his tally sheets and reports. To the scaler this information is of prime importance. The shape and extent of rot columns in logs showing decay at one end only and the presence of rot areas as betrayed by various signs on the exposed surfaces of the log when neither end shows decay are difficult to determine under any circumstances, yet the more information obtained regarding these defects the easier and more nearly accurate will be the determination. Aside from the ability to judge the board feet contents of a tree and of a stand of timber the cruiser must know what cull percentage to apply in reducing the sound volume on account of decay. Likewise, one of the main values of a scaler lies in his ability to judge the extent of hidden rot defects and to recognize the visible ones.

A knowledge of wood rots is of particular importance to scalers and to a lesser extent cruisers connected with pulp and paper manufacturing companies. Certain white rots are now being utilized in making newsprint pulp and with time the list of utilizable wood rots will grow. In both callings the outward signs are used to estimate the shape and extent, and therefore the volume of rot within the trunk or log. To do this better the cruiser and scaler must first know something of the causes of decay and of the kinds of decay produced in wood.

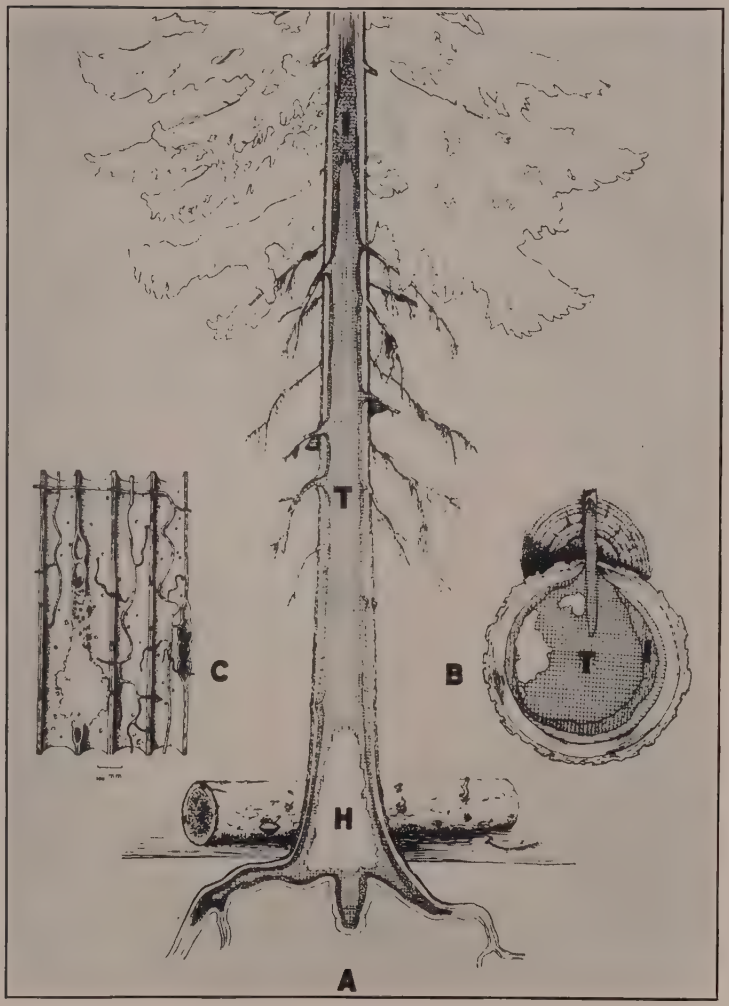
What Is Wood Rot?

Wood rot is caused by the attack of tiny plants called fungi which have no green coloring matter and which feed upon the contents of wood cells or upon the cell walls. This feeding process results in the decomposition of the wood and continues to the point where the wood becomes pitted, ring-scaled, soft, spongy, stringy, crumbly or broken up into irregular or cube-like brownish fragments.

Wood-rotting fungi attack both heart and sapwood, the latter usually proving less resistant to the attack, and from this fact we have the state-

FIGURE 1

Diagram showing the heart rot in western hemlock (Tsuga heterophylla) caused by the Indian paint fungus (Echinodontium tinctorium). A—Section through living tree showing the extent of decay with hollow cavity at H, late stage of rot at T, early stage of rot at I, and a hidden phase of early decay beyond this. The rot extends into the larger branches and into the roots. B—Cross-section of the trunk showing relation of decay to sporophore or conk and to dead branch. C—Tungential section of infected wood greatly magnified, showing the threads of the fungus penetrating the cell walls and decomposing them. Note the numerous bore holes caused by the fungous threads and tending to weaken the walls


T
T
C
B
T
H
A

ment that sapwood is less durable than heartwood. Similarly, on account of its thinner cell walls and greater porosity, or its different chemical composition, the spring wood of the annual ring offers less resistance to the attack of wood-rotting fungi than the summer wood. This often results in a type of decay called ring scale or ring rot, in which the annual rings separate from each other. The particular changes in the appearance and properties of wood brought about by the action of wood rot organisms give us the various rots, dotes, dozes, punky wood and decays, terms familiar to both woodsmen and lumbermen. These changes are usually very gradual, but for convenience we may divide the decay process into the two main stages, the early stage of decay, in which the fungus is invading the wood tissues and is just beginning its destructive action (Fig. 1, I); and the late stage in which decomposition has progressed to a marked degree (Fig. 1, T). The late stage of decay is usually the more readily recognized of the two, since in this stage there is always visible sufficient evidence that decay is present. In the early stage, however, infection may be present in the wood, but with no discoloration to indicate its presence, and we have as a result the so-called hidden stage of decay which is common to most of the brown rots (Fig. 1).

The life history of a wood-rotting fungus is briefly this: The tiny invisible spores, which are somewhat similar to the seeds of green plants, are carried by air currents or other agencies to a moist spot on a dead branch or other injury on a living tree. The spore germinates much as a grain of wheat sprouts, tiny threads begin to grow and branch out penetrating the wood tissues by dissolving their way through the cell walls. Soon the heartwood becomes networked with these threads and the wood begins to soften and decay. After decay has progressed for some time a fruiting body (comparable to the seed-producing organ of green plants), commonly called a punk or conk, is formed on the outside of the tree. This conk has been built up with the reserve food taken from the rotted areas at the expense of the sound wood and soon is capable of producing thousands of tiny spores which are liberated from the lower surface and are free to be carried by air currents to nearby trees. (See Fig. 2.)

Classification of Wood Rots

Since the decay in wood is a progressive and necessarily a chemical reaction (Fig. 2) it is not surprising to find that infected wood usually undergoes a color change during the progress of the decay. The nature of the attacking fungus, however, determines whether the rotted wood becomes whitish because of the removal of certain lignin-like substances, bleaching or other causes; or whether the infected tissues become yellow, red or brown due to a cellulose dissolving action, or to other causes not already understood. We find, therefore, that a particular type of decay is produced in wood by a specific fungus; and a certain species of fungus produces quite similar rots in different species of woods, with occasional minor variations.

A further study indicates that most wood rots may be classified under two main heads: white rots and brown rots (1).

The white rots are usually whitish in the areas where decay has reached the late stage. These areas are principally composed of white cellulose compounds or are bleached to a white color as the result of the fungus activity. The white rots may be divided into white pocket rots, white ring rots, white mottled rots and white spongy rots. The brown rots are usually yellowish, reddish or brownish in the areas where decay has reached the late stage. These rots are usually produced by fungi that attack the white cellulose compound of wood and leave the darker lignin compound. The subdivisions of the brown rots are: brown pocket rots, brown ring and stringy rots, brown cubical rots, brown spongy rots and brown mottled rots.

Wood rots are very often placed in two main divisions, heart rots and sap rots, on the basis of the parts of the wood attacked. We may also have sap rots of living sapwood as well as of the dead sapwood. Very often a sap rot invades the heartwood and occasionally a heart rot may encroach upon the living or dead sapwood.

The heart rots may be classified with respect to the longitudinal portion of the tree attacked. The rots found in the main part of the trunk are termed trunk rots (Fig. 1); those found in the upper trunk, top rots; those found in the basal portion, butt rots. The butt rots usually extend into the heartwood of the larger roots and similarly the trunk rots may extend into the larger branches (Fig. 1). Root rot is usually a sap rot of the living roots and may cause the death of the tree. (See references 1 to 6 under List of References.)

Sap Stains

Most of the discolorations of the sapwood are caused by fungi that do little or no damage to the wood. Blue stain is a good example and where present merely degrades the stock on account of the discoloration. Brown sap stain (7) may be grouped under those stains that do not affect the strength properties of the wood. It is mentioned here because it makes its appearance in stored logs and is often mistaken for an early stage of decay on account of its dark brown color. It should, however, be scaled or graded as firm sap stain and not as decay.

When judging sap stain in standing dead trees or in logs there is one important fact to keep ever in mind. If blue stain is present it indicates conditions favorable to fungous development and therefore wood rot organisms may also have entered the wood. Blue stain may develop in sapwood within 48 hours after the log is cut, but it may take two or more months before certain sap rots or heart rots show the least sign to indicate their presence. Wood rot fungi are more likely to appear with sap stain in fire or insect-killed timber or in logs left too long in the woods than in lumber properly piled for air seasoning. Care must therefore be exercised in scaling fire or insect-killed timber and in scaling logs left in decks for

FIGURE 2

Diagram showing the life cycle of a wood rot fungus in a conifer. A—Spores, highly magnified. B—Spores germinating, young threads produced. C—Threads growing and branching. D—Sound wood cell. E—Wood cell in which the decay is just starting. F—Wood cell showing late stage of decay. Note the corrosion of the cell wall and the bore holes left in the walls by the fungous threads. G—Section of log showing early and late stages of rot, branch stubs and old conk (H) attached below branch stub and shedding spores (I)

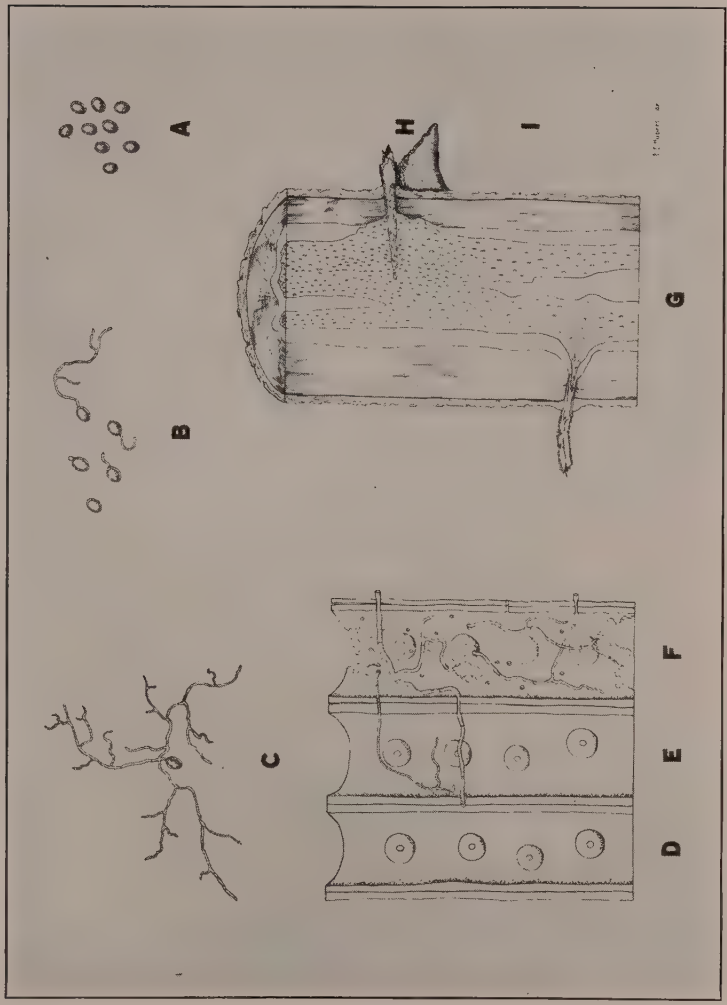

A
B
C
D
E
F
G
H
I

TABLE 1

Outward Signs Indicating Presence of Decay in Trees and Logs

Name of Rot	CONKS					Punk Knots	Swollen Knots	Soundings	Resin Flow	Injuries	Rot Area at End of Log
	On Trunk	On Roots	Fallen on Ground	On Ground Near Roots	On Logs or Down Trees						
Red Ring Rot.....	X	0	X	0	X	Brown	X	Rare	X	X	Crescent shaped to Circular.
Red Ray Rot.....	0	0	0	0	X	White	0	X	0	X	Radiate.
Spongy Root Rot....	0	X	0	0	Rare	0	0	X	X	X	Circular.
Pitted Sap Rot.....	0	0	0	0	X	0	0	0	0	0	In Dead Sap Wood.
Red-Brown Butt Rot.	Rare	X	0	X	Rare	Brown	0	X	X	X Basal	Circular.
Brown Stringy Rot...	X	0	X	0	X	Rusty Red	X	X	0	X	Circular.
Brown Trunk Rot....	Rare	0	Rare	0	X	0	0	X	X	X	Circular.
Brown Crumbly Rot	X	X	0	0	X	0	0	X	0	X	Circular.
Brown Top Rot.....	X	Rare	0	0	X	0	0	X	0	X Broken Tops	Circular to Patchy.
Yellow Ring Rot.....	0	X	0	0	X	0	0	X	0	X	Circular.
Brown Sap Rot.....	0	0	0	0	X	0	0	0	0	0	In Dead Sap Wood.
Red Root Rot.....	0	0	0	X	0	0	0	0	0	X Basal	Circular.
Brown Mottled Rot..	X	0	0	0	X	0	0	X	0	X	Circular.

more than two months during the warm seasons. The time of year when cutting takes place is an important consideration, as winter-cut stock is less likely to sap stain than spring or fall-cut stock, because cold weather does not favor the development of the sap stain fungi and by the time warm weather again appears sufficient seasoning has taken place to render the logs less susceptible to staining.

The Principal Cull Producing Wood Rots

The principal wood rots of the Inland Empire regions are taken up in the order of their importance as cull-producing defects. For each rot is given the common name, the names used but less desirable for various reasons, the group and sub-group the rot belongs in, a description of the early and late stages of the rot, data regarding the form and extent of the rot column, outward signs that may be used to estimate the decay in trunk or logs and a list of the wood species in which the rot is commonly found. A description of the conk in each case will be found under "Outward Signs of Decay."

As an aid to the ready comparison of the outward signs common to the various wood rots a table (Table 1) has been prepared indicating by "X" or by terms those signs that may be used by cruisers and scalers in determining the presence and the amount of decay.

The following list may be of value to cruisers and scalers interested in the utilization of infected wood for paper pulp. As the investigations on the suitability of wood rots for pulp progress new fungi will, no doubt, be added to the list.

Wood Rots Suitable for Certain Grades of Paper Pulp

Red ring rot, caused by *Trametes pini.*

Red ray rot, caused by *Polyporus anceps.*

Spongy sap rot, caused by *Fomes annosus.*

White pocket rots, often ringed or spongy, caused by *Stereum sulcatum, Stereum sanguinolentum, Stereum chailleti.*

Spongy root rot caused by *Poria subacida,* and possibly many of the remaining white rots.

Red Ring Rot

(Ring scale, conk rot, firm red heart, pecky rot, dozy rot, etc.). Group: White rots. Sub-Group: White pocket rots.

This is a white pocket rot of conifers caused by the ring scale fungus, *Trametes pini.* It usually occurs in patchy, crescent-shaped (Fig. 3B) or uniformly circular areas in the heartwood when viewed at ends of logs, occupying the main trunk but occasionally developing as a butt rot in stands where basal fire scars are common. A heart rot of resinous woods and a heart rot or a sap rot of woods having little or no resin, common to nearly all conifers of the region, and probably the most important cull-producing rot.

FIGURE 3

A—Conks (Trametes pini) issuing from a fire scar at the base of a western white pine. B—The typical ring scaled or crescent-shaped areas of red ring rot in a white pine log. Compare this with the form of red ray rot

A
B
1A 2

Rot Description

EARLY STAGE OF DECAY.—Pink to reddish or purplish discolorations of the heartwood, appearing in ringed, crescent-shaped, irregular or uniformly circular areas at ends of logs. The color is usually reddish purple in Douglas fir, pink to reddish in western white pine, usually darker shades of red in western yellow pine, and faint or indistinguishable from dark colored heartwood in other species. In this stage the wood is usually firm and tough and is often termed "red heart" or "firm red stain." This discoloration shows no pockets and precedes the white pocket stage. Heavy infiltrations of resins are often observed in the early decay areas.

LATE STAGE OF DECAY.—The wood is of the same or darker color as in the early stage, but contains few to many spindle-shaped, rather sharp-pointed, small cavities or pockets usually filled or lined with white cellulose fibers. The pockets run parallel to the grain and are separated by firm, sometimes resin filled strips of apparently sound wood. In larch, hemlock and pines the pockets may be confined to the annual ring and may run together in the spring wood causing the rings to separate, producing the characteristic ring scale. In western yellow pine and Douglas fir the pockets may be scattered throughout the infected wood and not show the ring scaled character. In some cases the pockets may be empty of cellulose fibers or the rotted area may be a mass of white fibers with no pockets showing. Brownish to blackish thread-like lines are frequently found irregularly distributed throughout the rotted areas. The late stage is usually bounded by the discolorations of the early stage.

Form and Extent of Rot Column

TRUNK ROT.—Short to long columns of rot irregular in cross sectional areas and conical in both directions from the area of greatest decay or from punk knot, conk or injury, in many cases extending full length of trunk, in others localized at branch whorls or injuries, are characteristic of this defect. When extending full length of trunk and circular in cross sectional area the rot column is conical at top; when in crescent or irregularly shaped areas it is tapering toward top. From a single conk, the rot may extend two to four feet up the trunk or log and from four to six feet downward; the first distance given in each case is the more common. In coast Douglas fir the rot extends about 20 feet beyond highest and lowest conk and 10 feet beyond highest and lowest swollen knot (6).

BUTT ROT.—The rot column extends from one to six feet up into the butt log and has a somewhat conical or tapering form.

For scaling rules used for this rot see Knouf's "Trade Course in Log Scaling" (3).

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks are bracket or shell to hoof-shaped (Fig. 3), grayish to brownish black, often with yellowish brown margins; and showing

concentric ridges parallel to margin; the under side is brownish with large, somewhat irregular pores. A new layer of pores is added each year and the conks may remain on the tree for several years. The interior portion or content is yellowish brown, punky to corky. The conk varies somewhat in size, shape and color with the species of tree attacked.

Decay is indicated by the presence of conks at butt (Fig. 3A), middle section or top of trunk, rarely on roots. The conks are usually attached under dead branches along the trunk (Fig. 2H) or to the trunk at branch whorls or at injuries such as fire scars. Number of conks, age and position on tree also aid in determining the location of rot areas, extension up and down the trunk, and amount of rot. (Table 2.)

PUNK KNOTS (conk knots, blind conks, etc.)—These are brown punky accumulations in old knots indicating, in old age classes, the points from which old conks have fallen, and in young age classes an attempt to form a conk at the knots. In blind conks the punk knot is usually overgrown with new wood and bark and it is often necessary to chop into these areas with an axe in order to expose the punky contents (frontispiece). In fire-killed timber the punk knots burn hollow and indicate the presence of decay. In old stands the spruce and white pine veterans show peculiar outgrowths at the branch whorls. When chopped, these projections, varying from small knobs to branch-like stubs two to eight inches long, are found to be composed of the brown punky substance mixed and covered with resin. These

TABLE 2

Red Ring Rot and Red-Brown Butt Rot in Western White Pine

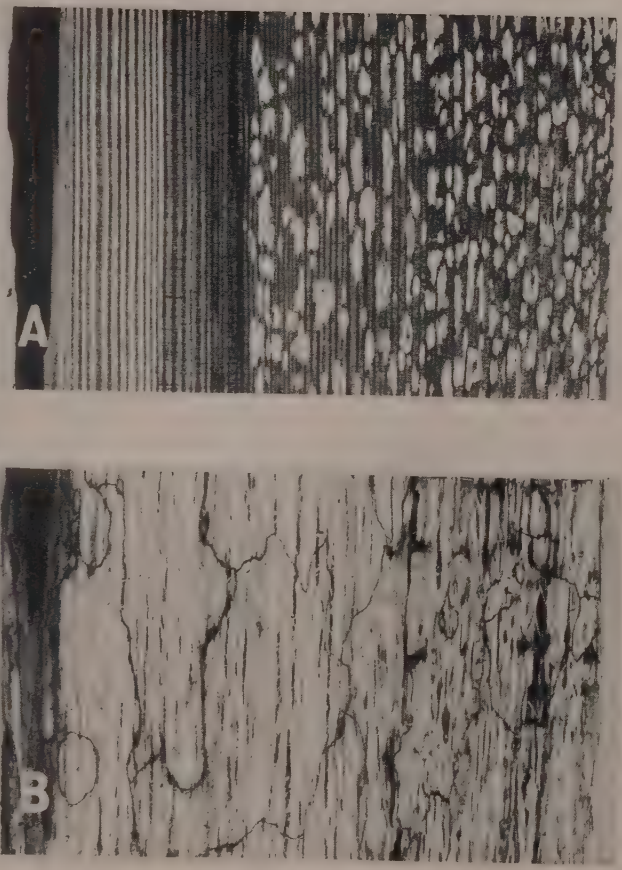
Age Class Years	BOTTOM SITE				SLOPE SITE			
	Rot Per Cent	Average No. Conks per 100 Trees	Per Cent Trees Bearing Conks	Per Cent of Trees Infected	Rot Per Cent	Average No. Conks per 100 Trees	Per Cent Trees Bearing Conks	Per Cent of Trees Infected
41— 60	0	0	0	0	0	0	0	0
61— 80	0.16	11	3.2	6	0.06	0	0	7
81—100	0.72	63	21.8	37	0.37	0	0	24
101—120	1.67	140	41.4	64	0.45	15	7.0	41
121—160	3.12	220	43.4	67	2.34	183	44.6	74
161—200	15.67	74	27.6	94	2.36	62	23.2	83
201—	18.30	46	23.1	97	14.67	34	12.8	98
Average....	7.8	110	29.8	55	6.1	80	21.7	55.3

(Compiled from U. S. D. A. Bul. No. 799). See Reference No. 5

Age of earliest infection, 50 years; age of greatest conk production, 121-160 year age class

FIGURE 4

A—Late stage (white pocket stage) of red ring rot in the heartwood of western larch. Note the early stage of rot, the dark band between the white sapwood and the white pocket area. B—Very late stage of red ring rot in western larch showing a mass of white fibers, indistinct pockets and numerous dark brown lines


A
B

are unmistakable signs on the lower trunk of conifers, particularly of the two species mentioned, that decay is present.

SWOLLEN KNOTS.—Swollen knots and swellings at branch whorls are frequent signs that red ring rot is present. (Fig. 5.) Swellings result as an attempt of the growing tissue to cover or "heal over" the knots where a conk is forming. Resin or pitch flow often accompanies swollen knots or whorls. Boyce (6) states that a swollen knot in Douglas fir is the forcing outward of the bark due to pressure of young conk emerging through knot.

HOLLOWNESS OR PUNKINESS.—Soundings made on the trunk may often indicate presence of decay by the hollow or punky sound produced when the trunk is struck with a hatchet or an axe. This is most reliable when rot has developed sufficiently to break down most of the heartwood.

INJURIES.—Numerous injuries, such as fire scars, broken branches, frost cracks, logging scars, lightning scars, broken tops, usually indicate that conditions favorable for the entrance of decay are present. Fire scars at base of the tree frequently result in development of butt rots (Fig. 3A).

AGE CLASS.—The age of the tree is a good indication of the amount of heart rot present (see Table 2); the older the stand the larger the rot or cull percentage.

ENDS OF LOGS.—Patchy, irregular, crescent-shaped, ringed or circular areas of pink, reddish or purplish discoloration in early stage and a firm white speckled appearance to a spongy whitish mass in late stages, are the principal indications at the log ends. Weathering of the ends of the logs as well as the accumulation of dirt during skidding and other operations often hide the defect.

SPECIES IN WHICH THIS ROT IS COMMON:

1, Western white pine; 2, western yellow pine (Pondosa pine); 3, Douglas fir; 4, western larch; 5, Engelmann spruce; 6, western hemlock; 7, lowland white fir; 8, western red cedar. Of lesser importance in the remaining conifers.

Red Brown Butt Rot

(Butt rot, brown butt rot, red rot, brown cubical rot, etc.)

Group: Brown rots. Sub-Group: Brown cubical rots.

A brown cubical rot of reddish brown color occurring principally in the roots and butt section of many conifers, and caused by the velvet top fungus, *Polyporus schweinitzii*. The rot is uniformly circular in cross sectional area and conical in longitudinal view; and usually limited to the first 16-foot log. One of the most destructive of the brown rot group and to be feared on account of its hidden stage.

Rot Description

EARLY STAGE.—A hidden stage of decay showing no discoloration occurs for some distance beyond the last trace of discoloration in the early stage of rot. Light yellowish to pale reddish brown discolorations are often

noted running into apparently sound wood as long spires of pale yellow color. Infected wood is soft, cheesy and moist in freshly cut wood.

LATE STAGE.—In this stage the wood is yellowish brown to dark reddish brown, breaking into cubes on drying, becoming crumbly and brittle and crushes to a smooth yellow powder. Thin resinous crusts of whitish to grayish felt-like fungus threads are often formed in the shrinkage cracks. The rot in this stage often has a turpentine or anise oil odor.

Form and Extent of Rot Column

BUTT ROT.—This is a typical butt rot occupying the heartwood of roots and butt section of tree. The rot column is conical from base of tree upward and may extend from one to 40 feet up in the trunk. In western white pine the rot rarely extends 14 feet up the trunk, the average height being from five to nine feet. This is a fairly common butt rot of Douglas fir in which the rot column may extend on an average 8 to 20 feet up in the trunk. For scaling rules see Knouf's "Trade Course in Log Scaling" (3).

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of this fungus are produced new each year—that is, annually. They are usually found growing out of the duff some distance from the base of the tree and connected to roots by fungous threads (Fig. 6A). The conk is soft when fresh, usually circular in shape, depressed in the middle, tapering to a stem-like base. When attached to trees, logs or stumps it is usually bracket-shaped, sometimes with two or more thin brackets growing one above the other. The upper surface is covered with a velvety layer; reddish brown with yellow margin in young conks, dark brown in mature conks, and approaching brownish black in very old conks. The under surface when fresh is dirty green, turning brownish when bruised, and contains large, irregular pores. The old conks remaining in the forest duff closely resemble old cow dung.

PUNK KNOTS.—When punk knots occur in butt logs they are of a dark brownish color; however, they are rarely observed.

SWOLLEN KNOTS AND RESIN FLOW.—These indicators are not present except at root injuries which coincide with points of entrance of the fungus.

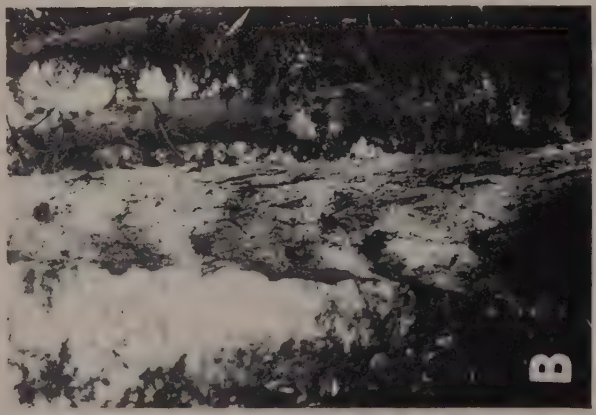
HOLLOWNESS.—Soundings made at the base of the trunk and along the flared portions of the butt are usually reliable indications of butt rot.

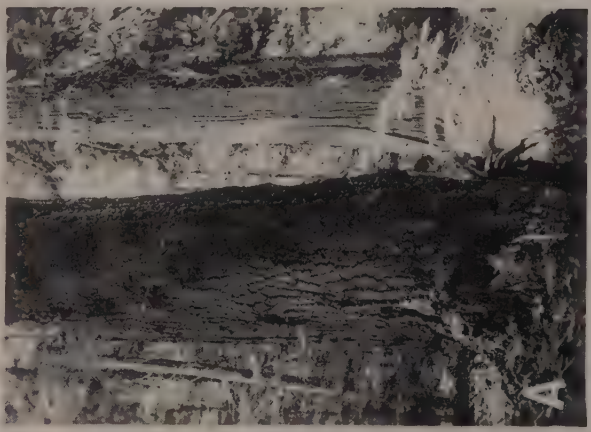
INJURIES.—Fire scars and injuries to exposed roots are good indications of butt rot. Experience in detecting healed injuries of various kinds is of great aid, and swelled butts should be examined carefully for signs of healed scars.

AGE CLASS.—From 41 to 80 years of age the western white pine shows but little butt rot. In the older age classes, particularly in the bottom sites, this rot becomes an important factor. (See Table 3.) A combination of old age with many basal injuries usually indicates butt rot. In other species this may vary somewhat.

FIGURE 5

A—Western white pine showing typical punk knots, indicating that the heartwood is quite thoroughly infected with red ring rot. (Photo by C. R. Stillinger.) B—Blind conks on the trunk of a western larch. The swellings at points where formerly the branches protruded are plainly visible and indicate presence of red ring rot. Both trees are culls due to heart rot


B


A

END OF LOGS.—Since this rot is usually confined to the butt log, butt end usually shows brown cubical rot in a uniformly circular area. Occasionally the late stage or more frequently early stage shows at top end of a 16-foot log.

SPECIES IN WHICH ROT IS COMMON.—1, Western white pine; 2, Douglas fir; 3, western yellow pine (Pondosa pine); 4, western red cedar; 5, lowland white fir; 6, spruce; 7, larch.

TABLE 3

Red Brown Butt Rot in Western White Pine

(From U. S. D. A. Bulletin No. 799)

Age Class Years	BOTTOM SITE			SLOPE SITE		
	Average volume of rot per infected tree (Cu. Ft.)	Number of infected trees	Number of Sound trees	Average volume of rot per infected tree (Cu. Ft.)	Number of infected trees	Number of Sound trees
41- 60	.....	.....	37	.....	.....	50
61- 80	.....	.....	58	0.14	1	56
81-100	1.2	5	73	0.16	13	74
101-120	2.4	8	40	0.30	11	59
121-160	2.5	3	43	6.0	18	61
161-200	281.3	4	4	5.1	21	17
201+	135.9	1	1	56.0	14	1
Total	61.6	21	256	12.9	78	318

Brown Stringy Rot

(Stringy brown rot, punky rot, hemlock rot, etc.)

Group: Brown rots. Sub-Group: Brown ring and stringy rots.

The brown stringy rot of hemlocks and firs is well known to most woodsmen, principally on account of its frequent occurrence in these trees and because it destroys so much of the sound wood. This rot is caused by the Indian paint fungus, *Echinodontium tinctorium* (Fig. 7) and usually occurs as a trunk rot uniformly circular when viewed at ends of logs, (Fig. 1, B). In older trees the rot occupies the entire heartwood extending into the heartwood of the roots and larger branches. Very frequently the trunk is reduced to a mere shell of sapwood. It is the principal rot of western hemlock, alpine fir and lowland white fir. Brown stringy rot of hemlocks and firs is found only in the western part of North America.

Rot Description

EARLY STAGE.—A hidden stage of decay showing little or no discoloration, is commonly found developing for some distance ahead of the

early stage of decay. This hidden stage usually extends from one to five feet beyond the faintest discolorations. The first recognizable sign of early decay is a softening of the wood accompanied by faint yellowish discolorations which gradually deepen in color to a pale reddish brown. Fine reddish brown to rusty red or blackish lines forming irregular outlines are often distributed throughout the early decay. A tendency to ring rot is also to be noted. (See Fig. 8.)

LATE STAGE.—In this stage the wood becomes soft, stringy, brownish, reddish brown or rusty red in color, frequently showing rusty red streaks. Brownish to reddish zone lines are often present and at times the rot shows white patches in the brownish colored rot. There is a frequent tendency to ring rot or a separation of the wood along the annual rings. In the very late stages of decay the butt section of the trunk may become hollow. (See Fig. 8.)

Form and Extent of Rot Column

TRUNK ROT.—Brown stringy rot is typically a trunk rot extending the full length of the trunk. The rot column is conical near the upper limits and usually occupies the entire heartwood in older trees.

In the early stages of development the rot is conical in both directions from the area of greatest decay or from conk or injury. The extent of rot in the trunk varies from a few feet in younger trees to the entire length of trunk in the older trees, where the rot extends into roots and branches. The area of cross section is usually uniformly circular except in alpine fir, where a radiate or star-shaped area is common.

For scaling rules used for this rot see Knouf's "Trade Course in Log Scaling" (3).

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks (Fig. 7) which are usually hoof-shaped, remain on the tree for several years, each conk adding new layers of growth every year and so increasing in size. They are numerous and are usually found growing at the branch whorls, attached to the trunk and to dead branch stubs. The average height of the conks on the trunk varies with the age of the tree, ranging from 8 to 45 feet and averaging about 40 feet up from the ground. (See Table 4.) Conks are found on young trees but may not be present on old trees where the conks have died and fallen from the trunk. These old conks do not deteriorate rapidly and may be found on the ground beneath the older trees. The conk varies considerably in size, ranging from young conks 1x1x1 inches in size to very old ones measuring 16x8x8 inches.

The upper surface of the older conk is almost black, with concentric layers of growth, showing numerous deep cracks at right angles. The younger and the living conks have a white to brownish margin which does not appear on dead conks. The context of these conks is a deep brick red

FIGURE 6

A—The conks of the velvet top fungus (Polyporus schweinitzii) growing from the duff at the base of a western white pine. This photograph shows how closely the conks resemble the duff upon which they are found. B—Red brown butt rot in a large butt log of western yellow (Pondosa) pine. Note shrinkage cracks

A
B

and when pulverized and mixed with oils or other liquids formed the ancient war paint of the Northwest Indians. The lower surface is usually covered with long spiny teeth except in very young specimens. This spiny layer is white during the growing season of the conk and grayish white at other seasons often showing red areas where the teeth have been broken off. The white layer covering the spines produces the numerous spores which are scattered by air currents (Fig. 1 and Fig 7). A single average sized conk located on the first 16-foot log indicates the log is a cull and that the rot may extend eight feet or more into the second log. A conk located along the second or third log indicates that the entire trunk contains very little sound or merchantable wood.

PUNK KNOTS.—Punk knots are valuable signs in the detection of this rot. They are called rusty knots because of the rusty red color that often appears in trees containing brown stringy rot. This color usually appears a half inch or deeper within the branch stub but may not show in all branch stubs and for this reason several should be tested. The more typical punk knots usually show a rusty red to reddish brown color and signs of the previous attachment of a conk are usually present on the bark surrounding the knot. In fire killed timber the presence of decay is often indicated by charred hollows where punk knots have developed.

SWOLLEN KNOTS.—Swellings at branch whorls and swollen knots are not such reliable indicators of decay in this rot as they are in the case of red ring rot. However, whenever found these signs indicate that considerable rot is present. Resin flow may be associated with these signs and may aid in a quicker determination.

TABLE 4

Brown Stringy Rot in Western Hemlock

(Compiled from U. S. D. A. Bulletin 722)

Age Class Years	BOTTOM SITE					SLOPE SITE				
	Rot %	Av. No. Conks per 100 Trees	% Trees bearing Conks	Av. Hgt. of Conks on tree.	% of Trees infected	Rot %	Av. No. Conks per 100 Trees	% Trees bearing Conks	Av. Hgt. of Conks on tree.	% of Trees infected
				Ft.					Ft.	
41-100.....	27.1	117	57.1	8	96.5	3.1	66	6.6	10	66.7
101-160.....	23.6	243	85.7	13	100.0	25.1	172	61.1	31	83.4
161-200.....	.....	.....	.....	.....	.....	31.1	400	86.9	40	100.0
201+.....	.....	.....	.....	.....	.....	33.8	344	88.0	45	100 0
Average..	26.6	125	58.8	10.5	96.7	30.8	386	66.6	40	90.1

Age of earliest infection, 40 years. Age of greatest conk production, 161-200 year age class.

HOLLOWNESS.—A hollow to punky sound resulting from pounding on the trunk is a common indication of decay in hemlock and the true firs. In older trees the butt sections of the trunks begin to form hollows as decay progresses. This is a fairly reliable indicator for brown stringy rot.

INJURIES.—As in the case of most trunk rots, numerous injuries usually indicate decay. In hemlock the branch stubs are rated first as sources of infection. With the increase in the age of the stand there is an increase in the amount of injuries and a corresponding increase in amount of decay. More branch stubs or dead branches are formed in dense stands and along bottom sites than in more open stands and slope sites.

AGE CLASS.—In hemlock the percentage of rot shows a definite increase with increase in age. In the slope sites, for instance, the rot per cent increases from 3 per cent in the 41-100 year class to 34 per cent in the 201 age class. Decay develops in very young trees, particularly in crowded stands and the average age of earliest infection is about 40 years. See Table 4 for additional data on western hemlock.

ENDS OF LOGS.—The ends of logs infected with the Indian paint fungus usually show a tan to reddish brown discoloration often streaked with a brick red color. The areas of rot are usually circular in outline filling the entire heartwood and showing a stringy appearance in which the rotted wood often separates readily into thin plates following the annual rings. In the early stage of rot the ends show discolored areas of a yellowish to reddish brown color and the wood fiber is pulled out irregularly by the saw thus producing a roughened surface. (See Fig. 8.)

SPECIES IN WHICH THIS ROT IS COMMON.—1 Western hemlock; 2, lowland white fir; 3, alpine fir; 4, mountain hemlock; 5, Engelmann spruce; 6, Douglas fir.

Red Ray Rot

(Western red rot, gray rot, anceps rot, gray trunk rot, etc.)

Group: White rots. Sub-Group: White pocket rots.

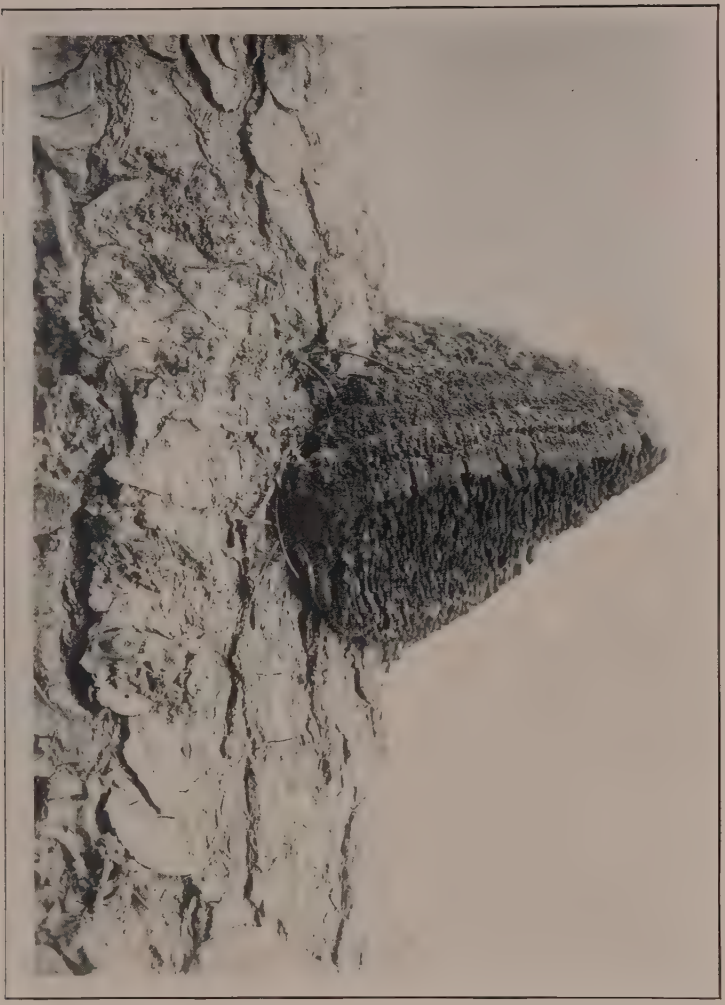
Red ray rot is common in western yellow pine (Pondosa pine) heartwood and has undoubtedly been confused with the red ring rot of conifers, but is caused by a white colored fungus, *Polyporus anceps* (Fig. 9A.) It is a trunk rot and is often characterized by a peculiar radiate outline when viewed in the ends of logs in contrast with the red ring rot which is irregular to crescent shaped in outline. The rot appears to be well distributed throughout the yellow pine regions, and is common as a top rot almost invariably associated with spike topped or broken topped trees in some areas.

Rot Description

EARLY STAGE.—In this stage the infected wood shows a reddish to reddish brown discoloration, the outer margins of discolored wood showing numerous radiate projecting areas of decay, like spokes in a wheel. At

FIGURE 7

Showing typical conk of the Indian paint fungus on western hemlock. Note the spiny structure of the lower surface. The core is a deep, rusty red color



times these projections are not pronounced and the rot area may have a general circular outline when viewed at log ends. In plain sawed lumber these areas often appear as small isolated areas of irregular outline. The discoloration is usually of a darker brownish shade than that found in the early stage of red ring rot. The white pockets have not yet formed in this stage and no evidence of a hidden stage has been found. Resin infiltrations in the areas of early decay are not common in this rot. (See Fig 9B and Fig 10.)

LATE STAGE.—The wood between pockets is of the same color as in the early stage, but contains numerous white pockets which have a tendency to form in the spring wood and run together in the direction of the wood fibers. The pockets are of about the same size as in red ring rot, but have blunt to squarish ends, and are much larger in the sapwood than in the heartwood. The tendency to run together, ring scale and form long white patches is greater in the sapwood. In this stage the wood is markedly weakened and in the older rot the infected area becomes soft and spongy. In the sapwood the rot often shows a white mottled pattern when viewed in tangential cut. The infected wood is easily pulled out from the ends of logs and in some cases small hollows are formed in the central part of the decay cylinder. No zone lines similar to those found in red ring rot are to be found. In the very late stages of decay the pockets may be empty of white fibers. (See Fig. 10.)

In spruce there is a tendency to ring scale with smaller pockets which at times show black flecks in the centers. Black flecks are sometimes found in the rotted sapwood of Pondosa pine.

Form and Extent of Rot Column

This is a typical trunk rot occupying the heartwood of most of the trunk from the base well up into the top. The rot column is roughly conical usually extending from 12 to 20 feet up the trunk in all but the oldest trees where the decay may extend higher. In certain regions it appears as a typical top rot associated with injured or spike top trees. In such cases the rot may extend 15 to 40 feet downward from the lower end of the dead top.

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of this fungus are small, white to cream color and somewhat irregular in shape. Occasionally they appear as short, thick shelf-like projections from the sides of logs and stumps (Fig 9A) but usually they are in the form of thick flat sheets of whitish fungus growth attached to the under surfaces of logs. The surfaces show numerous tiny holes or pores except at the margins which are smooth. New conks are produced each year and the old ones are rapidly destroyed by insects and other agencies. The conks are rarely found on living trees, but are common on stumps, logs, down timber, and slash. (Fig. 9A.) Small flat-

tened conks are often found in the spaces between the loosened bark and the infected sapwood of stumps.

PUNK KNOTS.—Punk knots are rare in standing trees, although occasionally ones are to be found on logs. When found they usually show a small amount of whitish punky growth at points where dead branch stubs once protruded from the bark.

SWOLLEN KNOTS AND RESIN FLOW.—Not observed.

HOLLOWNESS.—Soundings on the trunk will indicate presence of heart rot as in other trunk rots.

INJURIES.—Since most of the infection enters the living tree by way of the branch stubs and dead tops a large number of broken branches and injuries to the top may indicate decay. Fire scars at the base of the tree are also points of entrance for the fungus. The presence of woodpecker nest holes also indicates heartrot although this may not always be red ray rot as brown trunk rots are frequently found in the tops.

AGE CLASS.—Little is known regarding the relation of age to amount of decay caused by this fungus and until field studies yield reliable data it must be assumed that the rot per cent increases steadily with the age of the stand. The older age classes showing many trees with injured tops usually show a large cull per cent due to this rot.

ENDS OF LOGS.—The characters of the rot showing at the ends of logs are of real value in identifying red ray rot. The star-shaped or radiate outline of the rotted area is very characteristic (Fig. 9B) but in some logs this character is not pronounced, particularly where the rot completely fills the heartwood area. Numerous rays of infected wood extend from the central rot cylinder toward the sapwood. These rays are bordered by reddish brown areas of early decay and usually in the late stage surround grayish white areas of late decay. The central cylinder shows a mass of grayish white badly broken spongy fibers in the late stage while the early stage shows firm areas of a reddish brown color, (Fig. 9B and Fig 10A). Small hollows may appear in the central part of the butt logs at basal end.

SPECIES IN WHICH THIS ROT IS COMMON.—1, Western yellow (Pondosa) pine; 2, Engelmann spruce; 3, lodgepole pine; 4, western red cedar. (Also common in Canadian jackpine.)

Brown Trunk Rot

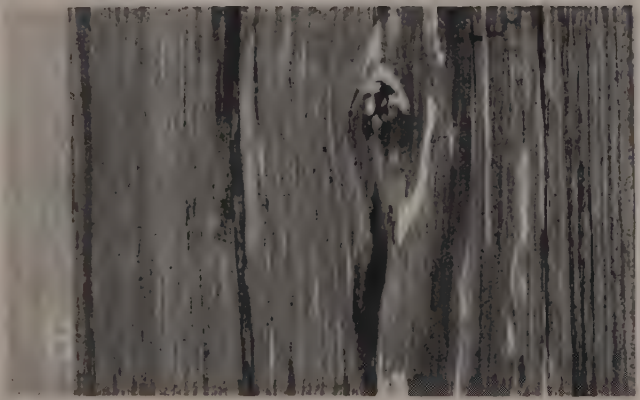
Red-brown heartwood rot, laricis rot, dry rot, brown cubical rot, etc.

Group: Brown rots. Sub-Groups: Brown cubical rots.

This rot is caused by the quinine fungus, *Fomes laricis (F. officinalis)*, (Fig. 11A) and is a heart rot common to the main trunk of the tree. It develops occasionally as a butt rot when infection takes place at the base of the tree. It is the most important heart rot of western larch and a common top rot in Pondosa pine.

FIGURE 8

A—Brown stringy rot caused by the Indian paint fungus in western hemlock. The stringy character of the rot is shown at the end of this log. B—Edge grain view of brown stringy rot in western hemlock. The dark streaks are of a rusty red color. The early stage is at the left merging into the white sapwood



Rot Description

EARLY STAGE.—As in most of the brown rots a hidden phase of decay precedes the visible stage. This extends for a few inches beyond the last faint discoloration in the wood. The early stage is yellowish to light reddish brown in color, the wood becoming soft as the discoloration deepens. In some woods, particularly Douglas fir, the early stage may show pinkish to reddish brown and even purplish discolorations.

LATE STAGE.—In this stage the wood is a dark reddish brown, easily crumbled mass broken up into cube-like particles by the formation of shrinkage cracks. Within these cracks are thin felt-like mats of interwoven fungous threads. (Fig 11B.) These mats are often resinous and in log ends appear in a cobweb pattern. The rot resembles that produced by the sulphur fungus *Polyporus sulphureus*, and it is difficult to tell them apart. In the rot produced by the sulphur fungus the mats are non-resinous, but appear as a cobweb pattern at ends of logs.

Form and Extent of Rot Column

Brown trunk rot is uniformly circular in cross sectional area and the rot column is somewhat conical from the area of greatest decay. It usually occupies the upper portion of the trunk in western yellow pine, but may be found in any part of the trunk in western larch. It is rarely found as a typical butt rot, but as such the rot column may extend 12 to 16 feet up the trunk. In comparison, the sulphur fungus usually produces a butt rot.

For scaling rules used for this rot see Knouf's "Trade Course in Log Scaling" (3).

Outward Signs of Decay in Trunk or Logs

CONKS.—The quinine fungus has large chalky white conks which develop new layers of growth each year. These conks grow to sizes approximating 16 to 24 inches in length where they develop as narrow pendulous growths and from 10 to 18 inches wide when bracket or hoof shaped. The upper surface is chalky white to brownish and is zoned showing a roughened surface. The lower surface is whitish with small regular pores. The context is soft when young but tough and chalky when old and has a very bitter taste.

The conks are rarely found. Usually they appear high up on the older trees, in elongated somewhat cylindrical shapes. (Fig. 11A.) Occasionally they are found in the fire scar cavities at the bases of infected trees where the shapes vary from cylindrical to broadly hoof shaped. In older stands the conks may be found on the ground having fallen from the tree.

The conks of the sulphur fungus are produced fresh each year. They are soft, cheesy and moist and are usually in groups of one to several thin shelf-like units attached to the trunk, stump, log or down timber (Fig. 12). The upper surface is orange yellow when fresh and white when old; the

lower surface is bright yellow when fresh turning to white with age. These conks decompose readily and rarely last over into the next season. The context has no bitter taste, but on the contrary may be used as food.

Sounding for hollows or punky condition in the lower trunk is a good way to detect this decay. No swelling at branch whorls, resin flows or punk knots have been observed in connection with this rot. The usual relation of age to amount of decay should hold in this rot although no accurate data have as yet been collected. Fire scars indicate entrance of decay through the base of the tree and broken or injured tops usually indicate top rot although the top rot may not always be the one caused by the quinine fungus.

ENDS OF LOGS.—The ends of infected logs show a more or less uniformly circular outline of reddish, purplish to brownish red discoloration in the early stage. In the late stage the area of rot is uniformly circular in the heartwood and usually shows shrinkage cracks following annual rings and also radiating from pith to sapwood. These cracks are usually filled with comparatively thin mats of white fungous growth forming a cobweb-like pattern. The rot usually breaks up into cube-shaped pieces.

SPECIES IN WHICH THIS ROT IS COMMON.—1, Western larch; 2, western yellow (Pondosa) pine; 3, Douglas fir; 4, Engelmann spruce.

Yellow Ring Rot

(Ring butt rot, brown poria rot, laminated rot, etc.)

Group: Brown rots. Sub-Group: Brown ring rots.

This is a ring scale rot common in the butt and root sections of western red cedar and is caused by the brown cedar poria, *Poria weirii*. This common rot of cedar causes considerable loss of sound material and is also responsible for a certain amount of windfall and wind breakage due to the weakening of the roots and trunk.

Rot Description

EARLY STAGE.—In the early stage the heartwood first shows a yellowish discoloration but retains its firm texture. As decay advances the wood becomes softer and the discoloration deepens.

LATE STAGE.—The late stage shows a yellowish to brownish discoloration, the wood is soft and flaky, the annual rings separating readily and forming a typical ring rot. The spring wood of the annual ring is easily decomposed by this fungus while the summer wood resists attack. Soft, thin webs of brownish fungous threads are often present between the easily separated layers of wood.

Form and Extent of Rot Column

Yellow ring rot is crescent shaped to uniformily circular in cross sectional view and the rot column when cylindrical is conical in shape at the upper end. The rot is rarely found extending the full length of the trunk,

FIGURE 9

A—The small white conk associated with red ray rot appearing upon the bark of a western yellow (Pondosa) pine stump. To the right the sapwood and heartwood are exposed, showing the white rot. B—Red ray rot in the end of a western yellow (Pondosa) pine log. Note the characteristic ray-like projections of rot

A
B

but frequently extends from five to ten feet up into the butt log. The roots are usually infected and as rot develops butt section of tree becomes hollow.

For scaling rules used for this rot see Knouf's "Trade Course in Log Scaling" (3).

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of the brown cedar poria are yellowish brown to dark brown flattened layers of fungous growth showing stratifications or layers. The under surface is of a yellowish brown color and contains numerous fine pores. The core or context is dark brown. The conk is usually found matted with the forest duff and is attached to the root crotches of living trees. In fallen material the conks are found in long layers attached to the under side of the tree, log or pole.

HOLLOWNESS.—Soundings on the trunk and root spurs often disclose the hollow condition of the butt section and roots. With practice this method can be used to determine how badly the tree may be infected. The rot may have developed in the root spurs on one side of the tree and the rot column may have extended upward on one side of the trunk only, leaving considerable sound wood on the other side. This condition calls for soundings on all sides of the trunk.

INJURIES.—Fire scars and injuries to the base of the tree and to the exposed portions of the roots indicate points of entrance for this fungus. Fire scars are perhaps the principal entrance points.

ENDS OF LOGS.—The cross sectional area of rot showing at the ends of logs varies from crescent shaped, patchy to uniformly circular. The crescent shaped areas are frequently observed. The rotted area, if in the late stage of decay, plainly shows the laminated or ring scaled character common to this rot.

SPECIES IN WHICH THIS ROT IS COMMON.—Found only in western red cedar and in eastern arbor vitae.

Brown Mottled Rot

Group: Brown rots. Sub-Group: Brown mottled rots.

This is a heart rot that is occasionally found in the true firs and the hemlocks and is of a yellowish to brownish color. Its infrequent occurrence in the more important trees probably accounts for the fact that not much attention has been paid to it. A brief outline of the rot and the fungus causing it will be included here, however, for completeness. The rot is caused by the yellow cap fungus, *Pholiota adiposa.*

The early stage of rot appears as light yellowish discolorations throughout the heartwood. In the late stage these areas darken and brownish streaks sometimes appear giving the rotted areas a mottled appearance. In old infected trees, principally of lowland white fir, the butt section may show hollow rotting. The narrow strands of yellowish to tan colored fun-

gous threads often found in the rotted wood may at times be pulled out in sawing or splitting the wood along the grain leaving narrow irregular channels or pits somewhat resembling insect burrows. This rot at certain stages may sometimes be confused with certain stages of the rot produced by the Indian paint fungus. The discolorations in the brown mottled rot are of a much paler color, however.

The rot is usually circular in shape when viewed at the log ends, occupies the main trunk and can be classed as a trunk rot. It is frequently confined to the lower trunk and tapers conically in its upper limits.

The conk is very characteristic since in general form it resembles the common mushroom. These conks, which are produced each year and are very soft, appear on the trunk in clusters, the stems centering at a common outlet in the bark. The upper surfaces are bright yellow, sticky when moist, and show several small flaky patches or scales. The stems are yellow and the gills are yellowish to brownish in color. Insects soon destroy them and since they appear only at certain seasons as in the fall, the conks do not serve as a year-round sign of decay.

The outward signs of decay are soundings on the lower trunk, presence of typical conks and presence of characteristic decay in exposed parts of tree.

This rot is of most importance in the alpine fir and lowland white fir, but also occurs in mountain hemlock, western hemlock, Engelmann spruce and western white pine.

Root Rots

(A group of white pocket rots found in the roots and butt sections of living conifers.) Group: White rots. Sub-Group: White pocket rots.

There are three important root rots of conifers that show white pockets in the late stage. The rots produced resemble each other quite closely and are therefor brought together for direct comparison. Red root rot is common to spruces and is caused by the stalked fungus, *Polyporus circinatus.* Spongy sap rot is caused by the fungus, *Fomes annosus,* and spongy root rot is caused by *Poria subacida.* These rots are found in various conifers and are typical root and butt rots.

Rot Description

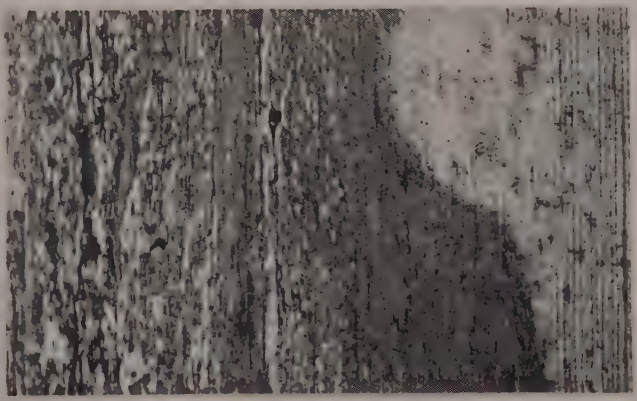
EARLY STAGE.—The early stage of red root rot appears as a band surrounding the white pocket or late stage, and is a dark reddish brown discoloration similar to that of red ring rot but much darker. The wood is firm and shows no signs of pockets in this stage.

The early stage of spongy sap rot is of a pinkish, reddish to lilac or dull violet color and shows little signs of decomposition.

The early stage of spongy root rot is inconspicuous, usually appearing as a faint darkening of the wood with faint outlines of pocket showing.

FIGURE 10

A—Edge grain view of red ray rot in the heartwood of western yellow (pondosa) pine. Late stage to the left showing white pockets and early stage to the right darkly stained but containing no pockets. B—Edge grain view of red ray rot in sapwood of western yellow (Pondosa) pine. Note long pockets with square ends



LATE STAGE.—The late stage of red root rot shows numerous long narrow elliptical pockets filled with white fibers. These pockets have pointed ends and often run together in the direction of the grain. The apparently sound wood between pockets is of a dark reddish brown. No zone lines are formed and no black specks appear in the pockets.

The late stage of spongy sap rot is characterized by the formation of pockets lined with white fibers. These pockets which appear in the spring wood are small and soon run together forming large masses of white spongy fibers. Occasional black flecks appear in the pockets or scattered throughout the white spongy masses. The rot is often found in the sapwood where the spongy white area is usually of a dull yellow or brownish color. The annual rings separate readily and a ring scale condition often results. (Fig. 13A.)

The late stage of spongy root rot has irregularly shaped pockets developing in the spring wood and soon running together to form continuous masses of white fibers. The rings separate easily from one another and the rot often appears ring scaled. In certain species, such as hemlock, small black flecks may appear in the white masses or in the small pockets. The heartwood finally becomes a soft spongy mass of water-soaked white fibers. In down material the rot invades the sapwood also. (Fig. 14A.)

Form and Extent of Rot Column

These rots are confined to the root and butt sections of living trees, rarely extending the full length of the first log. The average extent of the rot up in the trunk is from six to ten feet. In both the spongy sap rot and the spongy root rot the rotted areas may develop hollows at the base of the trunk. This does not occur in red root rot. Further studies of this rot may yield new data on the extent and form of the rot column.

Scaling rules used for red brown butt rot may be used in scaling these rots. (See 3.)

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks associated with red root rot are small, yellow brown to reddish brown growths growing out of the duff near the base of the infected tree. The conk is circular in shape, depressed in the middle, velvety, and attached to buried roots by means of threads issuing from a short to long stem which bears the circular cap. The under surface of the cap is brownish and contains angular pores which extend part way down the stem. The conks associated with spongy sap rot are bracket-shaped, zoned, and of a light to dark gray brown color. The under surface is white to yellowish and contains numerous regular pores. The conks are usually found attached to the base of trees at the root crotches or else attached to some portion of the exposed roots. Care should be exercised not to confuse the conks of this fungus with the small conks of the red belt fungus.

The conks of the spongy root rot are whitish, shiny layers of fungous growth usually attached to the under side of exposed roots or root crotches. They are also common on the under side of down logs and trees.

The presence of conks and soundings made at the base of the trees are the principal indications that these rots are present. Unusual numbers of windfall trees may indicate heavy root infection by one or more of these fungi and the root and butt portions of windfalls should be examined for conks and the characteristic rots. Fire scars and injuries to the base of the tree and to exposed roots indicate favorable conditions for decay, but will not determine the particular kind of decay that may be present. Conks or decayed wood must supply this information.

SPECIES IN WHICH THESE ROTS ARE COMMON.—1, Engelmann spruce; 2, western hemlock; 3, western white pine; 4, lowland white fir; 5, Alpine fir; 6, western yellow (Pondosa) pine; 7, lodgepole pine.

Brown Crumbly Rot

(Crumbly brown rot, brown cubical rot, pinicola rot, yellow-brown rot, etc.) Group: Brown rots. Sub-Group: Brown cubical rots.

A brown rot common in the heartwood and sapwood after the tree is dead. Occasionally it is found in the heartwood of the living tree in which case the red belt fungus *Fomes pinicola*, causing this rot acts as a wound fungus penetrating tree through injuries. The rot is found in all parts of trunk of most conifers and is most common rot of dead and down material.

Rot Description

EARLY STAGE.—A hidden phase of the early stage of decay extends several inches beyond the last faint discoloration in the wood. The early stage shows a narrow band of faint yellowish to yellowish brown discoloration accompanied by a distinct softening of the wood, surrounding the areas of late decay.

LATE STAGE.—The late stage shows characteristic crumbly cubical pieces due to the formation of shrinkage cracks. In this stage the color is usually yellowish brown but occasionally light reddish brown. In some woods such as lowland white fir, small scattered patches of a lighter color are observed giving the rot a mottled effect. The shrinkage cracks are usually filled with thick non-resinous fungous mats or felts often joined in cobweb patterns. When dry the rot is crumbly and brittle. (Fig. 13B.)

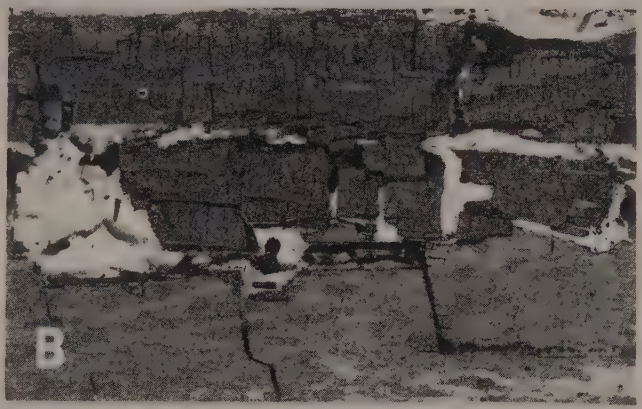
Form and Extent of Rot Column

The rot column is usually uniformly circular when viewed at log ends and tapers to an irregular point in both directions from area of greatest decay. The extent of the rot column up and down the trunk is variable.

Scaling rules for this rot are similar to those used for red ring rot (3).

FIGURE 11

A—Conk of the quinine fungus (Fomes laricis) on yellow pine. B—Late stage of brown trunk rot caused by Fomes laricis in western larch. Note the shrinkage cracks filled with thick white mats of fungous threads. Flat grain view


B

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of the red belt fungus are very common in most coniferous forests. They are usually flat to hoof-shaped, rather large growths attached to trees, snags, stumps or down timber. They are often found on cull logs or logs left too long in the woods. New layers of growth are added each year and the layers are indicated by the zoned structure of the top which is smooth and of a gray to black color. The conks usually show a red shiny margin, hence the name. During the growing season the margins are cream white as are the lower surfaces bearing numerous small regular pores. The context is leathery and of a whitish color, the annual layers showing plainly. Young conks are frequently found emerging as round white corky masses from bark crevices, branch stubs or injuries.

The presence of one conk on the middle portion of the trunk usually indicates that most of heartwood is decayed at least ten feet up the trunk and from 12 to 16 feet downward. A greater number of conks means a cull tree.

PUNK KNOTS.—The white corky masses protruding from old branch knots may be a good indication that brown crumbly rot is present in the trunk. Punk knots comparable to those produced by the ring scale fungus have not been observed for the red belt fungus.

The usual indications such as hollowness, injuries and age may be used to advantage in checsking this rot, but in general the presence of conks or typical punk knots must be relied upon for the necessary evidence.

ENDS OF LOGS.—Most of the brown cubical rots are difficult to distinguish one from the other and brown crumbly rot is no exception. In general, the outline of the rotted area, and the formation of checks and the pattern of the fungous felts are very similar to those found in the brown trunk rot. The cobweb pattern of the felts is characteristic but is not always present. However, the felts are usually very thick, non-resinous, of a dull white to cream or pale yellow color in brown crumbly rot.

SPECIES IN WHICH THIS ROT IS COMMON.—1, Western larch; 2, western hemlock; 3, lowland white fir; 4, Alpine fir; 5, Douglas fir; 6, western yellow (Pondosa) pine; 7, Engelmann spruce. (It also occurs in a few broadleaf species.)

Brown Top Rot

Group: Brown rots. Sub-Group: Brown cubical rots.

(Yellow-brown top rot, roseus rot, top rot, etc.)

This rot is of minor importance in the Inland Empire region and is also very difficult to detect by outward signs. The rot is caused by the rose-colored fungus, *Fomes roseus*, the conks of which are small and are usually formed high up on the infected trees. The detection of rot by the presence of conks is therefore very difficult. Injuries to the top are possibly the only signs that would indicate the presence of brown top rot.

The rot resembles closely the brown crumbly rot produced by the red

belt fungus. The early stage shows faint brownish discolorations with occasional brownish green margins in certain species such as Douglas fir. In the late stage of decay the wood is soft, crumbly, broken up into cube-like pieces and often shows thin fungous felts of a white to faint rose color in the shrinkage cracks. Occasionally the rot occurs in large pockets which may later run together. It is a typical top rot entering the upper part of the trunk through broken or spike tops, lightning or other top injuries.

The conks are rose-colored on the under surface and have a hard, rough dark-colored upper surface. The pores are small. The conks remain on the tree for more than one year and are most commonly found on Douglas fir, alpine fir, lowland white fir and a few of the remaining conifers.

Pitted Sap Rot

(Hollow pocket rot, sap rot, spongy sap rot, abietinus rot, etc.)

Group: White rots. Sub-Group: White pocket rots.

This is one of the most common sap rots of dead coniferous timber and is caused by the purple fungus, *Polystictus abietinus*. It makes its appearance within two or three years after the death of the tree and usually renders the entire sapwood useless for lumber. The fungus confines its action exclusively to the sapwood.

Rot Description

EARLY STAGE.—This rot has a rather indefinite early stage. The first evidence of decay is a faint yellowish to tan discoloration accompanied by a softening of the wood. Later the outlines of small white pockets begin to show.

LATE STAGE.—In this stage the shallow pockets may be filled with whitish fibers, later the pockets are empty and only narrow strips of apparently sound wood are left between the pockets. The pockets are confined to the annual rings and often produce a ring scale condition by the easy separation of the annual rings. The rotted wood in this stage is very spongy resembling the cellular structure of the bullrush plant. No zone lines are found in this rot. (Fig. 13C.)

Form and Extent of Rot Column

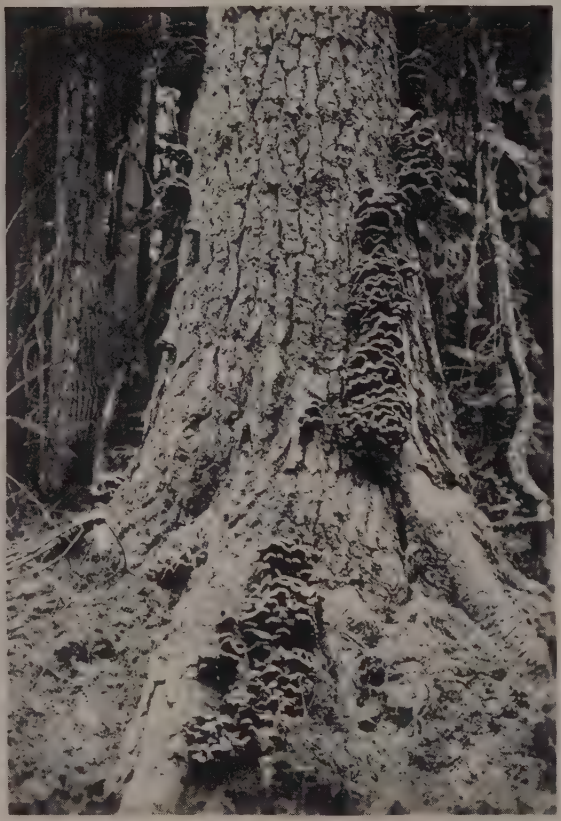
The rot column takes the shape of the sapwood cylinder and in heavily infected material the entire sapwood will be decayed. The extent of the rot along the log, down tree or standing dead tree may usually be gauged by the distribution of the small conks over the bark.

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of this fungus are quite small, thin and bracket-shaped, but very numerous and develop best on down material located in fairly damp situations. The upper surface is hairy, zonated and of a white

FIGURE 12

An unusually large number of conks of the sulphur fungus on a living western white pine. These conks appeared in large numbers soon after a fall rain



to grayish color becoming blackish when old. The lower surface is of a purplish color with regular to irregular pores. The conks are produced new each year and several of them may be crowded along bark crevices or other openings on the sides of logs or down trees or they may be grouped one above another on stumps or snags. The presence of these conks indicates that the sapwood beneath and near these conks is too seriously decayed for commercial use. On the ends of logs the conks are often grouped along the sapwood ring.

ENDS OF LOGS.—The sapwood at the ends of logs shows in the early stage of rot a yellowish discoloration unless masked by blue stain. In the late stage the wood appears spongy and discolored. This spongy condition can soon be determined by the use of the hatchet or the ferrule of scaling stick and the character and extent of the rot exposed to view.

SPECIES IN WHICH THIS ROT IS COMMON.—1, Western yellow (Pondosa) pine; 2, western white pine; 3, lodgepole pine; 4, lowland white fir; 5, western hemlock; 6, western red cedar; 7, Alpine fir; 8, Engelmann spruce 9, Douglas fir; 10, western larch.

Brown Sap Rot

(Brown pocket rot, brown cubical rot, sepiaria rot, slash rot, sap rot, etc.) Group: Brown rots. Sub-Group: Brown pocket rots.

This brown pocket rot common in the sapwood of dead timber causes serious losses in stored logs or in dead timber which is not salvaged soon enough after fire, insect damage or windfall. The rot is caused by the slash fungus, *Lenzites sepiaria*, or related species, and is often found invading the heartwood after the sapwood is destroyed. In its rapidity in destroying sapwood it is on a par with the fungus causing pitted sap rot. Brown sap rot may be looked for in logs and timbers exposed to the sun and wind and not in contact with moist soil. In this respect it differs from the pitted sap rot.

Rot Description

EARLY STAGE.—The wood in early stage of decay has a hidden phase which extends a short distance beyond the faintly discolored areas. The discolorations are pale yellow to light brown in color and the wood is soft and brashy, separating easily along the annual rings in some woods.

LATE STAGE.—The late stage shows dull yellowish to yellowish brown discolorations which occur in irregularly shaped pockets. Later these pockets run together as decay develops and form larger streaks of irregular shape extending lengthwise with the grain. The wood is soft, crumbly, light in weight and breaks up into small cubical pieces which crush easily. The shrinkage cracks are sometimes filled with small, thin, yellowish to brownish mats or felts.

This rot is more irregular in its distribution throughout the sapwood than is the pitted sap rot. When heavily infected, however, the sapwood will be quite uniformly decayed. Conks distributed along the sides of logs, down trees and dead standing trees may aid in determining the distribution of the rot. In the case of sapwood rots removing the bark and exposing the infected sapwood by means of a hatchet or scale stick may prove helpful.

Outward Signs of Decay in Trunk or Logs

CONKS.—The conks of this fungus which are somewhat bracket-shaped, usually appear at bark crevices, branch knots, surface checks and other openings in logs, snags, windfalls, etc. They are more frequently found on the sides of down trees and on logs. The conks are small, zoned and of a bright yellow red to dark brownish color on the upper surface; with a brownish lower surface filled with very irregular pores. The context is brown and leathery when dry. New conks are produced each year and the old ones often remain attached to the wood for some time. The presence of one conk may mean a small or a large area of rot and should be checked. The presence of saveral conks, however, usually indicates considerable decay.

ENDS OF LOGS.—Pockets of brown rot, or more frequently continuous areas of rot including the entire sapwood zone occasionally give direct evidence of a badly decayed condition of the sapwood whenever the exposed ends have remained fairly moist. Where the exposed ends have dried out rapidly the rot will not show on the surfaces but may appear a few inches back from the sawed ends. The ends of such logs may readily be tested by the use of the ferrule on the scale stick. Logs with most of the bark attached are more likely to develop sap rot than are the "buckskin" logs and should therefore be given more attention, particularly since this sap rot may extend into the heartwood. Conks attached to the ends of logs along the sapwood zone are good indicators of decay. The excessive checking of the sapwood area on the log ends may also be used as a sign.

SPECIES IN WHICH THIS ROT IS COMMON.—1, Western yellow (Pondosa) pine; 2, lodgepole pine; 3, Douglas fir; 4, western larch; 5, western white pine; 6, lowland white fir; 7, alpine fir; 8, Engelmann spruce; 9, western hemlock.

Slash Rots

Group: White rots. Sub-Group: White pocket rots.

These include a number of rots, principally white pocket rots which develop in fallen trees, logs and slash and which may cause considerable cull in stored logs, poles, posts, and similar products. Pulp logs containing these white rots may be used for certain grades of paper pulp.

FIGURE 13

A—Late stage of spongy sap rot caused by Fomes annosus in western white pine. Note the black spots in some of the white pockets. Edge grain view. B—Late stage of brown crumbly rot caused by Fomes pinicola in the heartwood of lowland white fir. Note the thick fungous mats in the shrinkage cracks. C—Late stage of pitted sap rot caused by Polystictus abietinus in western hemlock

A
B
C

There are several white pocket rots which develop in poles, logs, fallen trees and slash of the various tree species common to the Inland Empire region. The principal signs used in distinguishing the several rots are the kinds of conks produced and the differences in the size of the white pockets.

Fomes nigrolimitatus, the black line fungus, produces a rot having very large circular to egg shaped pockets, 3/16″x5/16″ to ¾″x¾″ in size rarely 2″ or more, separated by ¼″ or less of apparently sound wood. The pockets are filled with white fibers which show cracks or appear in parallel strands due to the fact that the pockets cover more than one annual ring and include the more resistant summer wood cells. In Douglas fir the pockets are somewhat circular in outline, while in larch, the most common host, the pockets are elongated with somewhat pointed ends. (Fig. 14B.)

Several species of Stereum: *S. sulcatum, S. chailleti, S. sanguinolentum* produce white pocket rots which are difficult to separate from each other. The pockets are usually small, less than 5/16″ in largest diameter, and have a tendency in the first two species listed to run together forming large masses of shiny white fibers. (Fig. 14C.)

Trametes isabellina produces a rot showing very small elliptical pockets less than 3/16″ in diameter which are usually confined to the annual ring. The pockets run together in the direction of the grain and produce a ring scaled effect. This is a common sapwood and heartwood rot of dead and down timber.

CONKS.—The conks of *Fomes nigrolimitatus* are thick, flat sheets of dark brown fungous growth usually attached to the under side of infected fallen logs or trees. The lower surface shows numerous small regular pores and when in a growing condition the margin of the new growth has a yellowish brown color. The context is dark brown, in layers, and has numerous fine black lines running through the older portions.

The conks of the species of Stereum differ greatly from those already described. In these fungi the fruiting layer is a large, somewhat thin flat sheet of fungous growth attached to the lower surfaces of logs, down trees and slash or may be somewhat shelf shaped, and occasionally found attached to stumps or snags as in the case of *S. sulcatum*. The lower surface is smooth, usually wrinkled or cracked but bears *no pores* and is of a grayish color with tan margins, becoming blackish with age.

Conks of *Trametes isabellina* are small, thin, shelf shaped, but more commonly flattened structures of a yellowish brown to grayish brown color. The lower surface contains numerous small pores. These conks are attached to the sides or lower surfaces of logs, or down timbers which are in contact with the soil. The rot is aften present in the wood before conks appear and this adds to the difficulty of detection.

SPECIES IN WHICH THESE ROTS ARE COMMON.—These rots are found in down material located in fairly moist situations and are more likely to occur in logs that have the bark covering them than in "buckskin" logs.

Logs or trees in contact with the ground are also more likely to contain these rots since a moisture supply soaked up from the moist earth and duff aids in their continued development.

The rot caused by the black line fungus is common in western larch, Douglas fir, Pondosa pine, lodgepole pine, western red cedar and less common in the other conifers.

The white pocket rots caused by the species of Stereum are common in fallen merchantable timber of Engelmann spruce, western larch, western white pine, lowland white fir, western hemlock, and a few others.

The small pocket rot caused by *T. isabellina* is common in western white pine, lodgepole pine, western larch, western red cedar, and may occur in any of the conifers.

The Common Rots of Broadleaf Trees

Broadleaf trees have a large number of fungi attacking them and causing decay in the wood. This is particularly true of the fallen trees, logs, and stored products. Care must be used in storing green, freshly cut cottonwood, aspen, alder, birch and maple for sap rot as well as heart rot soon develops and in many cases the stored material has lost a large percentage of its sound volume by the end of the first year and may be worthless at the end of the second year. This applies particularly to large piles of pulpwood logs or bolts.

In the region covered by this handbook the only species of hardwoods that are cut extensively for commercial use are the poplars, including black cottonwood, balm-of-Gilead, Fremont's cottonwood and trembling aspen. The same wood rot fungi readily attack all of these species, which for practical purposes we may group under the common term poplar.

There are two principal heart rots of poplars which account for the majority of cull due to rot in these species and there are perhaps three outstanding sap and heart rots of fallen timber and stored wood. The two heart rots are also known to develop rapidly after the tree is killed. With both groups of rots developing at a rapid rate, it is small wonder that poplar wood deteriorates so rapidly.

White Mottled Rot

White mottled rot in poplars is caused by the shelf fungus, *Fomes applanatus*. This fungus produces a butt rot and at times a trunk rot of the heartwood and is credited with the ability to attack the living sapwood producing a rot similar to that in the heartwood. Since the heartwood of poplars is of a light color, it is not always easy to detect the early stages of this rot. Usually the early decay area is bordered by a dark brownish zone or band of discolored wood. The late stage of decay is whitish to cream colored, very soft and spongy, showing numerous areas of white bleached wood or patches of white fungous threads which give the rot area

FIGURE 14

A—Late stage of spongy root rot caused by Poria subacida in western white pine. The wood is a mass of white cellulose fibers with only a trace of the earlier pocket formation. Flat grain view. B—Late stage of a white pocket rot caused by Fomes nigrolimitatus in western larch. Note the large size of the pockets, which show a characteristic pitting or cracking. Flat grain view. C—Late stage of a white pocket rot caused by Stereum sulcatum in western larch. The white pocket and spongy condition are both shown. Edge grain view

a mottled effect. Fine black zone lines are often found in this stage of the rot.

The conks are distinctly shelf-shaped, large when old, and are attached to the trunk usually near the base. They are also common on stumps, snags, and all fallen or cut material left on the ground for a sufficient length of time. The upper surface is zoned with a grayish to grayish black thick horny crust which is sometimes covered with a layer of brownish powder. The core or context is soft and corky, of a dark brown color, and shows distinct layers which are added each year. The under surface is white when fresh, becoming yellowish with age and showing brown discolorations when bruised. The fact that the brown color shows through the white layer when it is scratched or bruised has made this conk popular as an etching material. Designs and messages may readily be inscribed upon the lower surface at the time when new growth is being added.

The presence of conks and of immature conks on the tree and at times on the roots, the age of the tree, presence of many injuries and soundings made on the trunk are the principal outward signs used in the detection of this rot.

This fungus is found attacking a number of broadleaf species and is occasionally found on western hemlock and on lowland white fir.

White Trunk Rot

This rot is possibly the most common of the long list that are found in hardwoods. The fungus causing the rot is called *Fomes igniarius* and is found attacking trees of all age classes and in various species mixtures. The living sap wood is also invaded and the tissues killed, thus causing additional damage. The fungus continues to develop in the wood after the tree is dead.

The early stage of decay as seen at the end of a log appears as an irregularly shaped yellowish white area in the heartwood. This area is usually bounded by a yellowish green to brownish black band or zone. As decay progresses into the late stage the wood becomes soft, whitish and shows few, if any, cracks. The rotted wood, when viewed at the log ends, now contains numerous fine distinct and concentrically placed black lines very irregular in outline. The wider band encircling the early stage of decay is also present. The area of decay is usually irregular in cross-sectional view but may extend up the trunk for several feet.

The conks are usually hoof-shaped, hard, woody, and of a grayish black to black color. The upper surface shows regular arched zones and numerous cracks in the old conks. The core or context is dark brown and shows distinct layers. The lower surface is brownish and contains numerous pores. The conks of this fungus are usually found attached to wounds of various kinds, but more commonly at branch stubs on the upper, and less frequently

on the lower trunks of living trees. Imperfect conks resembling punk knots are frequently observed.

The usual outward signs may be used in the detection of this rot. The conks on the tree are fairly common and very characteristic. Quite often there appear at dead branch stubs, rounded woody, cracked masses of a black color, which when removed show a dark brown punky core. This is an immature conk and a good indication of white trunk rot. Some of the branch stubs show typical punk knots and these disclose a brown punky substance when chopped into with a sharp tool. A careful survey of the trunk for such signs will often be rewarded when examining older poplars.

The two principal white rots of the heartwood and sapwood of fallen poplar wood are caused by *Polystictus hirsutus* and *Polystictus versicolor*. These two rots account for most of the deterioration of fallen or stored poplar wood. The principal sapwood rot of dead poplars is caused by the fungus *Polystictus pargamenus*. This is a shallow white pocket rot resembling closely the pitted sap rot produced by *P. abietinus* in conifers.

White Pine Blister Rust

The white pine blister rust can, in no way, be classed with the defects already dealt with in this handbook, yet its relation to the future of white pine stands in the Northwest and Pacific Coast regions is of such importance that some mention of it is essential. Furthermore, the timber cruiser may prove to be very helpful in furnishing data of value to organized control of the disease. Information regarding the location and extent of blister rust infections will aid greatly in direct control operations aimed at checking the advance of the disease into valuable mature timber or of keeping it out of young growth that promises a heavy yield at maturity.

The cruiser's work takes him into remote forest regions where but few penetrate, and for this reason his chances are excellent for finding and reporting isolated or extensive areas of blister rust infection. Such a service is of inestimable value to the owner of the timber for whom the cruise is conducted and to the owner of adjacent white pine timber. In order to render such service the cruiser should become familiar with the seasonal appearance of this destructive disease so that he will be able to identify it in the forest. Since wild currants and gooseberries play an important part in the spread of this rust some attention should be given to the number and distribution of these plants in relation to the white pines. All infections of blister rust on white pines and on currants and gooseberries should be reported without delay to the federal and state agencies* engaged in

* Office of Blister Rust Control, Bureau of Plant Industry, Spokane, Washington; U. S. Forest Service, Missoula, Montana; School of Forestry, University of Idaho, Moscow; School of Forestry, University of Montana, Missoula, Montana.

FIGURE 15

Upper photograph shows the western white pine attacked by the blister rust. Note the white blisters breaking through the bark. Photographed in British Columbia by C. R. Stillinger. Lower view shows the summer stage of the disease on a leaf of Ribes aureum, the yellow-flowered currant. Note the numerous fine, hair-like growths. Spores from these growths are carried to white pines and there produce the blister stage which girdles the tree

the organized control of this disease. Some of the material should be sent in for examination in case there is doubt as to the identity of the disease. Care should be exercised to prevent the spread of the disease. Killing the fungus in the sample by heating or by the use of antiseptics is suggested. The specimens should then be mailed in a container from which spores may not escape. It is very important to kill the fungus before shipping the specimens.

The following brief life history of the fungus causing this disease is given for the purpose of making the identification in the field easier:

The blister rust fungus attacks all five-needle pines of which there are four in the western states, namely: western white pine, sugar pine, white bark pine and limber pine. The disease is caused by a fungus which attacks pines only after having grown on the leaves of currants and gooseberries part of the season. During its growth in the pine the blister rust fungus lives in the bark where its presence is not noticed for the first year or two. The tree once infected, the bark slowly swells and within several years after the infection the white blisters, which give the fungus its name, push through the bark crevices early in spring. (Fig. 15.)

When these blisters open they are seen to be filled with a mass of orange yellow powder—the spores. These spores are similar in function to seeds and are carried about by the wind, thus infecting the leaves of currant and gooseberry plants. On these plants the disease begins to appear in early summer as yellow rusted areas on the underside of the leaves. The spores produced from this stage of the rust cannot infect pines but reinfect the leaves of nearby currants and gooseberries, thus spreading the disease from one bush to another. In late summer the summer stage of the disease is produced on these diseased leaves, which begin to show numerous small, brownish, hairlike projections or bristles on their lower, and rarely on their upper surface. (Fig. 15.) On these hairs, spores are borne that are capable of infecting the pines but cannot reinfect the currant or gooseberry. It is obvious that the removal of currants and gooseberries breaks the life cycle and constitutes a method of control.

The disease kills pines, particularly young growth, by developing in the bark and girdling the trees. Cankers form as a result of the killing action of the fungus, and these, when established on a limb, may spread the disease to the trunk, finally causing death. One method of controlling this disease is by the eradication of all currants and gooseberries. Since the cultivated black currant, on account of its readiness to take the disease and the ease with which it distributes the spores, is the most dangerous plant in the spread of the disease, several states, including Idaho, have made it illegal to grow or possess these plants.

INDEX TO WOOD ROTS

In order that the cruiser and scaler may more readily keep in mind which of the wood rots belong under the white rot and which under the brown rot group, and to familiarize him with the common names, the following list has been prepared with the page indicating where the description of each may be found.

WHITE ROTS:

WHITE POCKET ROTS:

Red Ring Rot, caused by *Trametes pini* in living trees 13
Red Ray Rot, caused by *Polyporus anceps* in living trees 29
Red Root Rot, caused by *Polyporus circinatus* in living trees 41
Spongy Sap Rot, caused by *Fomes annosus* in living trees 41
Spongy Root Rot, caused by *Poria subacida* in living trees 41
Slash Rots, caused by various fungi in slash and other down material 53
Pitted Sap Rot, caused by *Polystictus abietinus* in logs, poles, windfall, insect and fire killed timber 49

WHITE SPONGY ROTS:

White Trunk Rot, caused by *Fomes igniarius* in living broadleaf trees 60

WHITE MOTTLED ROTS:

White Cubical Rot, caused by *Polyporus borealis* in living spruce 57
White Mottled Rot, caused by *Fomes applanatus* in living broadleaf trees 57

BROWN ROTS:

BROWN POCKET ROTS:

Brown Top Rot, caused by *Fomes roseus* in living trees 48
Brown Sap Rot, caused by *Lenzites* species in logs, poles, windfall, insect and fire killed timber 52

BROWN CUBICAL ROTS:

Red Brown Butt Rot, caused by *Polyporus schweinitzii* in living trees 20
Brown Trunk Rot, caused by *Fomes laricis* in living trees 33
Brown Crumbly Rot, caused by *Fomes pinicola* in live and dead trees 45

BROWN RING AND STRINGY ROTS:

Brown Stringy Rot, caused by *Echinodontium tinctorium* in living trees 24
Yellow Ring Rot, caused by *Poria weirii* in living trees 37

BROWN MOTTLED ROTS:

Brown Mottled Rot, caused by *Pholiota adiposa* in living trees 40